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**United States Department of Agriculture**  
**AGRICULTURAL MARKETING SERVICE**

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**RESEARCH IN SAMPLE FARM CENSUS METHODOLOGY**

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**PART I**

**Comparative Statistical Efficiency of  
Sampling Units Smaller than the  
Minor Civil Division for Estimating  
Year-to-Year Change**

(Analysis Based on State Farm Census Data)

Prepared with the Assistance of the Work Projects Administration  
for the City of New York

August, 1939

[New York, N. Y.]







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This study was conducted by the Bureau of Agricultural Economics in 1937-'38. With the formal establishment of the Agricultural Marketing Service on July 1, 1939, the work (and personnel directly associated with the activity) was included among the functions transferred to the latter agency of the Department.

*The assistance given by the Board of Education of the City of New York in the publication of this report is gratefully acknowledged.*



## P R E F A C E

This report covers the first of a series of studies designed to investigate problems involved in sampling individual farm data. The field work for this particular study was financed largely by funds appropriated by the Bankhead-Jones Act of 1935 to the Department of Agriculture "to conduct research into laws and principles underlying basic problems of agriculture in its broadest aspects." The basic tabulations of the Iowa data were provided by the Iowa Works Progress Administration OP No. 465-72-3-118. The data for Marion County, Kansas, were compiled and analyzed by W. H. Pine, Department of Agriculture Economics, Kansas Agricultural Experiment Station. The remainder of the tabulations and the task of summarizing and analyzing the data for all 19 counties were handled by Projects No. 365-97-3-22 and No. 365-97-3-27 conducted under the auspices of the Works Progress Administration of New York City.

This study was made under the general guidance of the following committee: Frederick F. Stephan, Secretary, American Statistical Association (Chairman); Z. R. Pettet, Chief Statistician for Agriculture, Bureau of the Census; Dallas W. Smythe, Economist, Central Statistical Board; and Charles F. Sarle, Principal Economist, Agricultural Marketing Service. The following acted as consultants: W. F. Callander, Head Agricultural Statistician, Agricultural Marketing Service; A. Sturges, Agricultural Economist, and R. O. Been, Assistant Agricultural Economist, Bureau of Agricultural Economics; and T. W. Schultz, Head of the Economics Department, Iowa State College. The cooperation and suggestions of the following statisticians of the Agricultural Marketing Service were most helpful: M. M. Justin, Senior Agricultural Statistician (Indiana); W. H. Ebling, Senior Agricultural Statistician (Wisconsin); P. H. Kirk, Senior Agricultural Statistician (Minnesota); L. M. Carl, Senior Agricultural Statistician (Iowa); and H. L. Collins, Agricultural Statistician (Kansas). The field work on the farm identification was handled by W. A. Baldwin, Junior Agricultural Statistician; Harley M. Brewer, Assistant Agricultural Statistician; Eldon Shaw, Agent; Paul L. Warner, Junior Agricultural Statistician; and John W. Whittier, Assistant Agricultural Statistician, all of the Agricultural Marketing Service.

Charles F. Sarle,  
Principal Agricultural Economist,  
Agricultural Marketing Service.

July 15, 1939.



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# RESEARCH IN SAMPLE FARM CENSUS METHODOLOGY

## Part I. Comparative Statistical Efficiency of Sampling Units Smaller than the Minor Civil Division for Estimating Year-to-Year Change

By Irvin Holmes, Agricultural Statistician,  
Agricultural Marketing Service

### Background of the Problem

The idea of a sample census of American agriculture is not new. Sample enumeration technique has been employed in European countries; and for more than 10 years statisticians and economists have considered it the next logical development in the collection of agricultural data in this country. A conference was held at Iowa State College in the summer of 1936 to consider some of the problems involved in sampling individual farm data.<sup>1</sup> Considerable interest was shown in the subject. As a result of this conference a sample census research project was inaugurated early in 1937 with the Central Statistical Board, the Bureau of the Census, and the Agricultural Marketing Service co-operating.

The plan for a sample census of agriculture originally advanced by J. B. Shepard contemplated the use of the Minor Civil Division as a sampling unit with certain restrictions and modifications.<sup>2</sup> The administrative advantages of the Minor Civil Division are undeniable. The concentration of the enumeration in a comparatively few areas in each State would simplify the mechanics of the field work tremendously. The Minor Civil Division is the smallest political unit for which United States Census data are tabulated separately which is an important consideration in connection with the problem of tying sample data for intercensal years

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1. Proceedings of Conference on Statistical Methods of Sampling Agricultural Data. U. S. D. A. Mimeographed Publication, 1936.

2. Selection of Areas for Sample Agricultural Enumerations, J. B. Shepard, Journal of Farm Economics, May 1937.



back into the Census data for the base year. For crop and livestock estimating the Minor Civil Division possesses another decided advantage. As it is a definite geographical unit, its use as a sampling unit would facilitate the measurement of the movement of land into and out of agricultural production. Sampling procedures now employed by the Bureau of Agricultural Economics do not furnish a reliable measure of this very important factor.

The obvious advantages of using the Minor Civil Division as a sampling unit warranted a thorough investigation of its possibilities and limitations from a statistical standpoint. Studies made early in 1937 indicated that, with the great variability in agricultural data, the Minor Civil Division was too large a sampling unit to serve as a basis for county estimates. It could be used for estimates by areas, such as crop-reporting districts or type-of-farming areas, on a few major items which are well distributed among farms. Even then a 20-percent sample was the minimum requirement.<sup>3</sup>

### Objectives of Study

The problem of determining the correct sampling procedure for a sample census of agriculture involves two fundamental considerations: (1) the determination of type of sampling unit that will, under a given set of conditions, give the greatest accuracy with the minimum of administrative difficulty and cost; and (2) the determination of the size of sample necessary for a specified standard of accuracy. The expense of taking an annual sample census of agriculture would probably be difficult to justify unless such an enumeration-survey would furnish the basic data necessary for making estimates on major agricultural items by counties or type-of-farming areas. Accordingly, a project was outlined in September 1937 for investigating the statistical possibilities of sampling units smaller than the Minor Civil Division with respect to the measurement of year-to-year change on a county basis.

3. Research in Sample Farm Census Methodology. J. J. Morgan. Unpublished report.



### Sampling Units and Size of Sample

There are two basic methods commonly employed in making annual estimates of agricultural phenomena such as crop acreages and production, and livestock numbers. The first is the use of an independent annual sample as a base for "building up" or "equalizing" to a 100-percent figure. The second is the use of successive annual samples for measuring year-to-year change from a given base such as a census year. The study of the Minor Civil Division as a sampling unit, previously referred to, was based primarily upon an analysis of United States Census data for the one year 1935. The Agricultural Marketing Service has generally employed the second method—sampling of year-to-year change—in the preparation of State estimates of agricultural production and prices. This procedure has been based upon a recognition of the fact that the samples it now collects, primarily by mail, are too small and selective to be used in deriving estimates on an independent annual basis. It was decided, therefore, to shift the approach on this phase of the research to an empirical study of year-to-year change.

It was recognized at the outset that, from a practical administrative standpoint, a 20-percent sample would undoubtedly be the maximum attainable; and that under actual operating conditions, the size of sample might necessarily be considerably less than this figure. The annual Rural Carrier Acreage Surveys now made by the Agricultural Marketing Service in cooperation with the Post Office Department, represent approximately 4 percent of the farm land reported by the United States Census. It was decided, therefore, to limit the sizes of sample for study to approximately 10 percent and 20 percent.

Four types of sampling units were selected for study: the Random Individual Farm, the Judgment Route, the Random Single-Section Block, and the Random Four-Section Block. The individual farm or operating unit is the unit most commonly used in the enumeration of agricultural data. From a theoretical standpoint a sample of individual farms, selected at random and properly stratified, should give the



most accurate results, provided that idle farms are included in the original drawing. From the standpoint of cost of enumeration the Random Individual Farm Sampling Unit should, on the average, be the most expensive.

All of the five States selected for study were covered by the Public Land Survey. The original roads usually follow section lines; and the Minor Civil Divisions (political townships) are frequently, but not always, coincident with the standard survey townships of 36 sections of land each. The sampling units, intermediate in size between the Individual Farm and the Minor Civil Division, were, therefore, based upon the survey section of 640 acres. To approximate the 10-percent and 20-percent samples desired, units of 4 sections and 8 sections, respectively, were allotted for each survey township or its equivalent. Two types of sampling units (based on the section) were selected for study; the first, a random selection of 4 separate single sections per township, that is, 4 sections not necessarily contiguous; the second, a random selection of a block of 4 contiguous sections, generally a square block. These are hereafter referred to as the Single-Section Block and Four-Section Block Sampling Units.

For the 20-percent samples, 8 single sections and 2 four-section blocks were drawn for each equivalent survey township. As the State Farm Census data used for this study were already compiled on an individual farm basis, it was impossible to hold the size of the section sampling units even approximately constant. For the purpose of this study, the Single-Section and Four-Section Sampling Units are defined as covering all land included in the farms for which the farmsteads are located within the specified area. In effect, the section lines constitute a grid which was used as a basis for selecting clusters or groups of farms. The extent to which this approach could be used in a modified form—say with natural land marks or boundaries in States where the land was not publicly surveyed or where the section lines are not a matter of common knowledge—will need additional investigation.



Because of greater convenience in enumeration and possible cheaper cost of enumeration, there is a natural inclination on the part of the practical crop estimator toward the so-called "route" method. The Judgment Route Sampling Unit was defined to include a string of farms fronting on, and having the farm exit to, a given segment of road. The selection of this road segment was left entirely to the judgment of the State Agricultural Statistician who was assisted in some cases by an economist from the State Agricultural College.<sup>4</sup> In actual practice, the following principles were generally followed in setting up the Judgment Routes:

- (1) A starting point was indicated on an ownership plat map, preferably a point with an easily identified land mark.
- (2) Two routes were designated on the map for each Minor Civil Division, one being labeled "A" and the other "B." The "A" route was used for the 10-percent sample and the "A + B" routes for the 20-percent sample.
- (3) The designation of the routes was supposed to represent the statistician's best judgment based on his knowledge of the agriculture within the county. Actually the common procedure was to take a soil map of the county and lay out the routes so that they would cut across the various soil types as much as possible.
- (4) In laying out the routes preference was given to secondary roads rather than to State and National Highways.

To keep the size of sample reasonably comparable between the four types of sampling units, it was necessary to set up quotas for the Judgment-Route and Random Individual Farm samples. These quotas were arrived at by

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4. Obviously the combination of the route unit with the element of purposive selection partially invalidates any comparisons that may be made with the other three units. To furnish valid comparisons the study should also have included a Random Route Sampling Unit.



computing the average number of farms per section for each stratum (Minor Civil Division or combination of Minor Civil Divisions) and multiplying this number by the number of sections allotted for the samples. For each of the four types sampling units *two 10-percent samples were drawn, the second sample being exclusive of the first. The two 10-percent samples were combined to give the 20-percent samples.*

### The County Universe

The shift in approach—from an analysis of annual data to a study of year-to-year change—necessitated the use of relatively complete annual enumeration data for successive years. The only farm data of this nature available for such a study were the figures compiled in the State Farm (Assessors') Censuses in a few of the leading agricultural States.<sup>5</sup> Five States—Indiana, Wisconsin, Minnesota, Iowa, and Kansas—were selected, and an analysis was made, county by county, of the relative completeness and comparability of the State Farm Census data, both in comparison with the 1935 United States Census, and as between successive reports for the 3 years, 1935, 1936, and 1937. On the basis of this analysis, 19 counties were chosen for individual study: 4 in Indiana, 2 in Wisconsin, 4 in Minnesota, 6 in Iowa, and 3 in Kansas. As far as possible, these counties were selected to represent divergent types of farming.

The State Farm Census data are collected during the spring months by the assessors in the above States. In Iowa the enumeration is made as of January 1 for livestock numbers, with the data on crop acreage and production relating to that harvested the previous year. In all of the other States the enumeration is started later in the spring, usually March to June. The Indiana crop data used for this study also related to harvested acreages for the year preceding the enumeration. The Wisconsin, Minnesota, and Kansas acreage data relate to acreages planted or to be planted

5. Individual farm data from records of the Agricultural Adjustment Administration are purposely excepted. Sampling studies based on this material are now under way and will be covered by a separate report.

for harvest during the current year. In this report the years used relate to the date of enumeration—1935, 1936, and 1937.

For the purpose of this study it was necessary to establish a hypothetical "county universe" for each of the counties studied. Year-to-year changes in agricultural production as reported in census enumerations result from a combination of the following factors:

- (1) A change in the item, such as crop acreage or numbers of livestock, on the same farm for the 2 years.
- (2) A change in number of farms in operation.
- (3) A change in number of farms enumerated, that is, in completeness of enumeration.

In the Indiana, Minnesota, and Wisconsin counties where only the sample farms were identified it was necessary to use the published county data as the "county universe" figures, after these had been checked for accuracy of computation. In these counties the sample data furnish no measure of change in completeness of enumeration. In the Iowa and Kansas counties where an approximately complete farm identification was secured, the county universe was the county master tabulation of all identified farms for the 3 years. The item totals on these master tabulations were checked with the published State Farm Census data and the discrepancies were reconciled. The samples were then drawn from these master tabulations.

To allow for the fact that the Indiana, Wisconsin and Minnesota samples furnished no measure of change in completeness of enumeration, the crop acreage year-to-year changes were computed on the basis of ratio-relatives to all land in farms: for example, ratio of corn acreage to all farm acreage for 1937 divided by ratio of corn acreage to all farm acreage for 1936. This procedure was also followed for the acreage comparisons in the Iowa and Kansas counties in order to preserve comparability between all



counties. The livestock items were handled on a ratio-relative-per-farm basis for the Wisconsin and Minnesota counties and on a direct change basis for the Iowa counties and have consequently been summarized separately.

### Farm Identification

The Random Individual Farm samples necessitated no identification of farms, as to location within the Minor Civil Division; consequently, for the Indiana, Minnesota and Wisconsin counties these were drawn in the State office, directly from the 1937 assessors' records. In Indiana, the 1937 assessors' schedule included an item asking for the section, township, and range numbers for each farm. Hence, the farms for use in the Single-Section Block and Four-Section Block samples could also be drawn from the office records. The 1937 sample farms for these three sampling units were then matched back against the 1936 and 1935 assessors' books to locate "identicals" on the basis of name of operator and total farm acreage.

This preliminary office work required careful checking in the field. In the first place, it is obvious that not all reports showing the same operator's name and, approximately, or even exactly, the same acreage were necessarily for the same farm. Furthermore, the inclusion of the land identification item in the 1937 assessors' schedule upset the comparability of the reports to some extent. There was a noticeable tendency on the part of some assessors to divide farming units into separate tracts on the basis of the section location of each tract. It was necessary, therefore, to combine these "split" farming units, for all samples, in order to make the 1937 entries comparable with those for the 2 earlier years. In addition, the samples as drawn in the office might not include all farms that were in operation in any one of the 3 years. Farms that were idle or that had been missed by the assessor in the 1937 enumeration would be omitted from the tabulation. For this reason, it was necessary to check with each assessor as to the completeness of the tabulation for the Single-Section Block and Four-Section Block



Sampling Units. The Random Individual Farm samples could not be so checked for completeness but only for unmatched farms.

The Judgment Route samples were matched entirely in the field.<sup>6</sup> There were a few farms for which it was necessary to make a more or less arbitrary decision as to whether or not they fell within the definition of the road segment; even after the matter had been discussed with the assessor. In a few instances, the routes laid out by the State Statistician were not long enough to fill the farm quota. When this occurred the rule was followed of projecting the route in the same direction insofar as this was possible from the roads shown on the map. If this procedure carried the route to the boundary line of the Minor Civil Division and the quota was still unfilled, the same plan was followed by "backing up" from the original starting point. In other words, an attempt was made to preserve the direction of the route as originally laid out, and to avoid, as much as possible, any doubling back.

In Wisconsin where the assessors' data on farm location were incomplete, and in Minnesota where no data of this kind were available, all of the identification work had to be done in the field. In Minnesota, Wisconsin and Indiana the farm data recorded by village or town assessors were included in the samples. The Indiana Assessor's Census does not include separate reports for villages.

It was soon found that the above plan of farm identification had two serious limitations. As only the farms included in the samples were being identified there was no way of cross-checking the statement of the assessor as to whether or not a farm had actually been idle or had been omitted from the enumeration in any given year. The records could be examined, and this was done. But because of changes in size of farm and change in operator this was never conclusive, particularly if there had also been a change of assessors during the 3-year period. The fact that these

6. The terms "matched" or "identical" farm as used in this study means the same operating unit, regardless of change of operator or change of farm acreage.



so-called "omitted" farms occurred more frequently in 1935 and in 1936 than in 1937 led the field workers to suspect a definite memory bias on the part of the assessor. Then, too, because of farm work it was often impossible to interview assessors except in the evenings. Much time was being wasted in driving and in making contacts. And although the equivalent of 80 percent of all farms in a county was being covered, the material collected was useful only for the single study already outlined.

When the field work was started in Iowa, T. W. Schultz, Head of the Economics Department at Iowa State College, suggested complete farm identification in each of the counties selected for study. This plan was adopted for the Iowa and Kansas counties together with the changes in the organization of the field work itself outlined below:

Individual Farm Identification Cards were prepared in the State Statistician's office. These forms provided space for entering the farm number and section, township, and range numbers; as well as name of operator, total acres in farm, and page and line numbers from the assessors' record books for each of the 3 years. *All of the names in the assessors' books for all 3 years* were then matched for identicals and a card was prepared for each farm appearing in the records 2 or more years. Separate cards or tabulations were prepared for farms appearing in the record for only one of the 3 years. Township maps showing the location of all houses were secured; and these "farmsteads" were numbered consecutively for each Minor Civil Division.

A temporary office was set up in each county through the cooperation of the County Agricultural Agent or the Soil Conservation Committee of the Agricultural Adjustment Administration. One or more men, as necessary, were selected for each Minor Civil Division, and these men were employed to come to this central office and work with the field representative on the farm identification for his area. From one to two Minor Civil Divisions could be completed in a day under this plan, although this depended to a large



extent upon the aptitude of the local man, as well as upon the number of farms, and amount of turn-over in farm operators.

The general procedure was to work the map against the cards. The local man would take the map and call off the name of the current (1937) operator for a given farm number. The field representative would then search for this operator in his file of identification cards. If such a card were found, the field representative and local man would examine the data on it to decide if the entries thereon were correct. If any one of the 3 years had been left blank, or if it was necessary to delete any entry already on the card, another search was made through the cards and tabulations for the proper data. When a card was verified, the farm number, and section, township, and range numbers were posted, and the farm number was checked off on the map. If a card could not be verified within a reasonable time, it was passed by and a question mark was entered on the map. Tenant houses, empty farm houses, etc., were checked off and appropriate marginal notes made on the map. This procedure was continued until all farmsteads showing on the map had been accounted for. If any cards still remained, and this was usually true, the local man was questioned both with regard to omitted farmsteads, and as to whether or not the available data applied to any of the farmstead locations covered by the marginal notes. This continued until all of the data shown on the cards had been identified as to location on the map. Frequently a few cases in each Minor Civil Division remained unsolved at the end of the interview, but these could be worked out by special investigation. Because of the saving in transportation expenses, the cost of securing complete identification under this plan proved to be about the same as under the original plan of identifying only the sample farms.

In both Iowa and Kansas where the "complete" farm identification was worked out, the village or town assessor's data are excluded from the study. In Iowa, the State Farm Census breaks all farming units on Minor Civil Division lines, a practice that results in many "cross-line tracts" appearing



without name of operator on the records. All such tracts that were unidentifiable were excluded from the county universe tabulations. Operating units without farmsteads were credited to the section in which the bulk of the land was located. This was an important factor in the winter wheat area of Trego County, Kansas.

### Tabulation of Data

After the farm identification phase of the project had been completed it was necessary to transcribe the individual farm data from the original assessors' record books to prepared listing forms. For the Indiana, Minnesota and Wisconsin counties this involved the tabulation of only the sample farms, but for the Iowa and Kansas counties, the transcription covered the master listing of all identified farms as well as the separate tabulations for each of the samples. For the 19 counties the study involved data for 3 years for approximately 39,000 farms. Practically all items for which comparable records for 2 or more years were available were included in the tabulations. But the analysis covered by this report is restricted to the principal crop acreage, livestock, and economic items for each county. The work of transcribing and summarizing the data was done by the Works Progress Administrations of Iowa and New York City, by the Department of Economics and Sociology of Kansas State College, and by the Bureau of Agricultural Economics.

### Summary of Results

#### Average Size of Farm

Table I (page 13) summarizes the weighted indications on average size of farm for the 19 counties. In all cases the individual county averages were weighted by 1935 United States Census number of farms. It will be noted that the average for the State Farm Census is approximately  $2\frac{1}{2}$  percent above the United States Census figures, reflecting the omission of small farms on the part of the



assessors. All of the sampling units are above the State Farm Census figure which represents the universe from which these samples were drawn. The tendency for the Indiana assessors to "split" farming units in 1937 has already been commented upon. In addition it was observed that assessors, generally, followed no strict rule in defining a farm. Despite instructions asking for the enumeration to be made on an operating unit basis, many of them had enumerated on the basis of ownership. This is to be expected. The Judgment Route Sampling Unit shows an average size of farm markedly above that for the State Farm Census, and also above the figures for all of the other types of units. This leads to the suspicion that in identifying the farms along routes, there was a tendency for the assessor to forget small farms, especially those near villages. This supposition is strengthened by the fact that the counties showing the greatest differences on this comparison are all counties in which complete farm identification was not secured.

Table 1.—Sample weighted average size of farm, 1935, for 19 counties by sampling units, with State Farm Census and United States Census comparisons

SAMPLING UNIT	10-percent samples	20-percent samples
(Sample Farms)	Acres	Acres
Random Individual Farm	164.7	164.4
Judgment Route	169.6	170.6
Random Single-Section Block	160.8	161.5
Random Four-Section Block	163.6	163.1
State Farm Census (all farms)	159.5	159.5
United States Census (all farms)	155.7	155.7



## Weighted Errors of Estimates—

### Total Farm Land and Acreage of Principal Crops

In table 2 is presented a summary of the errors of estimates on the two items, total farm land and principal crops. The term "error of estimate" as used in this study and report refers to the percentage deviation of the estimate on an item from the universe total for that item. These percentage deviations were computed by dividing the sample year-to-year change by the universe year-to-year change. This assumes that the universe figure for the base year is known. The error of estimate could be computed with the year-to-year change as a base—since change is the phenomenon being sampled—but the other basis was used to preserve comparability with the studies of independent annual samples. The individual county errors of estimate were combined by weighting by farm land and by acreage of principal crops, signs disregarded. The county universe figures on year-to-year change shown in the table were derived from the county totals on all farm land and comparable acreages of principal crops. The "principal crops" item is a derived item for each county; that is, the comparisons on change for principal crops are based on the cross-added acreages of individual crops. The number of individual crops studied ranged from 8 to 13 per county. In this, and following tables, both the 1936/1935 and 1937/1936 comparisons are shown although these are not independent indications.

The sample indications on changes in total farm land have little if any significance. Even with a 20-percent sample for the counties where all farms were identified the amount of error frequently exceeds the universe change. The errors of estimate for the direct comparisons on principal crops reflect the effect of the errors of estimate on all farm land. For the ratio-relative comparisons<sup>7</sup> on principal crops the errors of estimate average less than the amount of the year-to-year change only for the 1936/1935 change. Because of

7. Ratio-relatives to all land in farms: i. e.,  $(1937 \text{ corn acreage} \div 1937 \text{ land in farms}) \div (1936 \text{ corn acreage} \div 1936 \text{ land in farms})$ . See footnote 6.



the drought in 1934 the year-to-year changes for the Iowa counties run up to as high as 37.5 percent increase, 1936/1935 (1935 crop year compared with 1934 crop year for the Iowa counties). The differences between sampling units do not appear to be significant. Doubling the size of sample reduced the errors of estimate (on the ratio-relative for principal crops) by about one-third for all except the Judgment Route Sampling Unit.



Table 2.—Weighted errors of estimates, total farm land and acreage of principal crops,\* for 19 counties, by sampling units, 10-percent and 20-percent samples.

SAMPLING UNIT AND COMPARISON	1936 / 1935							
	10-percent samples				20-percent samples			
	Total farm land (Direct) Percent	Principal crops (R.R.Land) Percent	Principal crops (Direct) Percent	Total farm land (Direct) Percent	Principal crops (R.R.Land) Percent	Principal crops (Direct) Percent	Total farm land (Direct) Percent	Principal crops (Direct) Percent
Random Individual Farm	1.45	1.43	1.38	1.38	0.97	1.21	1.38	1.21
Judgment Route	1.55	0.86	1.57	1.76	1.14	1.22	1.76	1.22
Random Single- Section Block	2.58	1.93	3.14	1.70	1.14	1.74	1.70	1.74
Random Four- Section Block	2.02	1.83	2.36	1.37	1.02	1.75	1.37	1.75
State Farm Census County Universe								
Year-to-year Change	—0.45	+2.80	+2.34	—0.45	+2.80	+2.34	—0.45	+2.34
SAMPLING UNIT AND COMPARISON	1937 / 1936							
	10-percent samples				20-percent samples			
	Total farm land (Direct) Percent	Principal crops (R.R.Land) Percent	Principal crops (Direct) Percent	Total farm land (Direct) Percent	Principal crops (R.R.Land) Percent	Principal crops (Direct) Percent	Total farm land (Direct) Percent	Principal crops (Direct) Percent
Random Individual Farm	3.34	1.99	3.62	2.44	1.07	1.94	2.44	1.94
Judgment Route	1.81	1.45	2.39	1.63	0.99	1.66	1.63	1.66
Random Single- Section Block	1.62	2.12	2.58	1.88	1.41	2.24	1.88	2.24
Random Four- Section Block	2.21	1.22	2.55	2.06	0.95	1.89	2.06	1.89
State Farm Census County Universe								
Year-to-year Change	+1.18	+0.92	+2.11	+1.18	+0.92	+2.11	+1.18	+2.11

\*Basis derived indications. See text.



Weighted Mean Errors of Estimates—Principal Crop  
Acreage Items

As the percentage error of estimate in general varies inversely with the acreage of the crop (proportion of farms growing the crop and average acreage of the crop per farm) the errors of estimate for the individual crop acreage items in each county were weighted (by current year universe crop acreages) to derive a weighted mean error of estimate. These weighted mean errors for each county were, in turn, combined by weighting by comparable universe crop acreage weights to derive a similar weighted figure for the entire group of 19 counties. Comparisons by sampling units and size of sample for these data are shown in table 3. For the 10-percent samples, the weighted mean errors range from 4.5 to 5.9 percent; for the 20-percent samples from 3.0 to 4.0 percent; or a decrease of approximately one-third in the error when the size of sample is doubled. Although the Random Individual Farm and Judgment Route Units show up generally best on this comparison, the differences are too small to be highly significant.<sup>8</sup>

Table 3.—Weighted mean errors of estimates of principal crop acreage items for 19 counties by sampling units, 10-percent and 20-percent samples.\*

SAMPLING UNIT	1936 /1935 comparisons		1937 /1936 comparisons	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	4.48	3.01	5.33	3.37
Judgment Route	4.86	3.33	4.88	3.04
Random Single-Section Block	5.90	4.01	5.47	3.66
Random Four-Section Block	5.34	3.47	4.84	3.48

\*Average number of items per county for both the 1936 /1935 and 1937 /1936 comparisons, 11.0.

8. In comparing errors of estimates for the four types of sampling units, allowance must be made for differences in size of sample. On the basis of all land in farms the "20-percent" samples for the Judgment Route Unit averaged nearly 9 percent larger and the Random Individual Farm 4 percent larger, than those for either of the Section Block Units. These are 1937 weighted averages for 19 counties. See Table 12, in the appendix.

## Percentage of Acreage Items Within Specified Error Limits

The number and proportion of items that could be estimated within a given degree of accuracy is interesting. The data in table 4 were computed using combined comparisons, 1936/1935 and 1937/1936. Weighting between counties was on the basis of number of items considered. In addition to the crop acreage items, account was taken of miscellaneous acreage items such as wild hay, other crops, idle land, plowable pasture, and seeds. If only the principal crops had been considered the percentages would have been higher than those given below.

Table 4.—Percentage of acreage items within specified error limits, 1936/1935 and 1937/1936 comparisons combined. Weighted averages for 19 counties, 10-percent and 20-percent samples.\*

SAMPLING UNIT	10-percent samples		20-percent samples	
	2.5-percent error limit	5.0-percent error limit	2.5-percent error limit	5.0-percent error limit
	Percent	Percent	Percent	Percent
Random Individual Farm	20.5	34.3	28.2	44.9
Judgment Route	21.6	38.8	27.0	42.6
Random Single-Section Block	17.9	30.4	24.3	40.5
Random Four-Section Block	19.0	30.6	25.7	42.8

\*Average number of items per county, 15.2.

The average number of items per county within the 2.5-percent error limit is only 3 for the 10-percent samples and 4 for the 20-percent samples. Raising the error limit to 5.0-percent increases these numbers to 5 and 6 respectively. Considering the small base, the differences between sampling units have no significance.



Weighted Mean Errors of Estimates for Livestock Items

Since the year-to-year changes for livestock were computed both on a direct comparison and on a ratio-relative basis, as discussed previously, the data for the Iowa and for the Minnesota and Wisconsin counties have been summarized separately. The weighted mean errors on these items show considerable variation. This may partially reflect the smaller number of counties considered, 6 as against 19 for the acreage items. For sheep, the weighted mean errors of estimate range from about 10 to 20 percent; for all of the other livestock items studied, from about 1 percent to 5 percent.

Table 5.—Weighted mean errors of estimates of specified livestock items for 6 Iowa counties by sampling units 1937/1936 comparisons, 10-percent and 20-percent samples.\*

SAMPLING UNIT	Horses		All cattle	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	3.11	1.45	2.15	2.01
Judgment Route	3.34	2.71	4.38	1.75
Random Single-Section Block	4.84	2.50	4.14	3.34
Random Four-Section Block	3.11	1.85	3.92	2.19

SAMPLING UNIT	Sheep		Sows bred for spring farrow	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	13.82	12.95	2.79	2.17
Judgment Route	18.56	14.89	3.44	3.22
Random Single-Section Block	13.76	11.01	3.09	1.88
Random Four-Section Block	15.61	14.84	5.68	1.79

\* Basis direct year-to-year comparisons.

Table 6.—Weighted mean errors of estimates for specified livestock items in 6 Minnesota and Wisconsin counties, 1936/1935 and 1937/1936 comparisons, 10-percent and 20-percent samples.\*

SAMPLING UNIT	1936 /1935 comparisons			
	Milk Cows		Hens	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm Judgment	1.79	1.54	1.90	1.04
Route	2.18	1.97	1.46	1.26
Random Single-Section Block	5.41	2.71	2.99	2.08
Random Four-Section Block	3.79	4.70	3.70	3.13

SAMPLING UNIT	1937 /1936 comparisons			
	Milk Cows		Hens	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm Judgment	3.78	3.39	1.73	2.02
Route	2.44	1.61	2.69	2.59
Random Single-Section Block	2.89	1.26	2.47	1.40
Random Four-Section Block	3.77	4.28	2.87	.87

\*Basis ratio-relative per farm (all farms) year-to-year comparisons.

Weighted Mean Errors of Estimates for Miscellaneous Items

Data on two miscellaneous items were summarized for this study: tractors in 6 Iowa counties and farm population for the 2 Wisconsin counties. The weighted mean errors on tractors are large in percentage; 4-10 percent. Most of the Iowa counties studied had considerably less than 50 percent of their farms reporting tractors but all had a pronounced upward trend in numbers. The problem of sampling, then, was almost entirely one of measuring the number of new owners. Doubling the size of sample reduced the errors on this item materially. The county universe changes on farm population for the Wisconsin counties were too small to have any significance.



Table 7.—Weighted mean errors of estimates on tractor items for 6 Iowa counties, by sampling units, 10-percent and 20-percent samples.\*

SAMPLING UNIT	1936 /1935 comparisons		1937 /1936 comparisons	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	10.55	5.17	6.63	3.67
Judgment Route	8.09	2.99	7.15	6.25
Random Single-Section Block	7.14	3.55	5.47	3.98
Random Four-Section Block	3.49	3.01	6.98	3.53

\*Basis direct year-to-year comparisons.

Table 8.—Actual change and errors of estimated change in farm population for two Wisconsin counties, 1936/1935 and 1937/1936 comparisons, 10-percent and 20-percent samples.\*

SAMPLING UNIT	1936 /1935 comparisons			
	Dodge County		Green County	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	—0.7	—1.3	—0.5	—0.6
Judgment Route	+1.8	+1.4	+0.4	—0.2
Random Single-Section Block	+0.4	+0.7	+2.9	+1.4
Random Four-Section Block	—0.3	—0.4	—2.7	—1.0
State Farm Census County Universe Year-to-year Change	—0.6		—0.1	

SAMPLING UNIT	1937 /1936 comparisons			
	Dodge County		Green County	
	10-percent samples	20-percent samples	10-percent samples	20-percent samples
	Percent	Percent	Percent	Percent
Random Individual Farm	—2.9	—0.5	—2.2	—1.0
Judgment Route	—1.5	—1.6	+2.3	+0.3
Random Single-Section Block	—0.4	—1.6	+2.0	+0.5
Random Four-Section Block	—2.7	—1.6	—0.7	—0.5
State Farm Census County Universe Year-to-year Change	+0.1		0.0	

\*Basis ratio-relative per farm (all farms) year-to-year comparisons.

### Analysis of Replicated Samples for Hancock County, Iowa

The original study was designed primarily as an empirical test of types of sampling units. For the counties in which complete farm identification was secured, a detailed internal analysis of the universe data is now possible. As a concluding step in this study of sampling units smaller than the Minor Civil Division, fifteen 10-percent samples were drawn and tabulated for each of five types of sampling units. This phase of the study was limited to Hancock County, located in northern Iowa. Five items were selected for this analysis—all land in farms, the two major crops (corn and oats), one minor crop (barley), and sows bred for spring farrow.

Three of the five types of sampling units were identical with those already considered—the Random Individual Farm, the Random Single-Section Block, and the Random Four-Section Block. It was impossible for the writer to set up any replicated Judgment Route samples which would furnish a valid comparison with those used in the original phase of this work. Accordingly it was decided to substitute a Random Route.

The procedure followed in drawing the samples for this unit was as follows: A starting point was selected by drawing at random an individual farm number for each one of the 15 samples in each Minor Civil Division. The direction of the route was then selected by numbering eight points of the compass and drawing at random. Using the farm identification maps, the route was traced out for each sample, and the farm numbers for all farms having exits on this segment road were transferred to a guide sheet. The original quotas were used in determining the number of farms to be included in the sample. Rules were set up regarding turns and other problems, and these were rigidly adhered to. When any element of choice entered into the problem the selection was made at random. In general the original policy was followed of extending the route in the direction drawn (and in the opposite direction if necessary) as far as possible, and doubling back along nearby roads was avoided.



The fifth type of sampling unit studied has been designated as the Purposive Single-Section Block. Four sections were selected for every 36 sections of land in a Minor Civil Division. With the aid of a county soils map the writer selected the various samples of four sections each, according to the following rules: (1) non-contiguous sections were to be chosen as far as possible; (2) the four sections were distributed among the major soil types, an attempt being made to keep this distribution roughly proportional to the total land area occupied by each soil type; (3) the repeated selection of the same combination of sections was avoided, regardless of rules (1) and (2).

The method of stratification was the same as that outlined for the first phase of this study.

An analysis of the results of these replicated samples is presented in table 9. It should be noted that the deviations there referred to are point deviations and not percentage deviations (errors of estimate) previously discussed. The differences between the Random Farm and Random Route Units, 1937/1936 change, appear to be significant for the all land and corn acreage items, and highly significant for oats acreage. On the latter item the Random Route Unit has a significantly smaller error than any of the other units. For sows bred, however, the Random Farm Unit is significantly lower than the Random Route. The barley item is illustrative of minor crops which obviously cannot be sampled with a limited survey. The total acreage of this crop in Hancock County ranged from 2,000 to 5,800 during the 3 years studied.

Table 9.—Standard Deviation\* of sample year-to-year changes for specified crop acreage and livestock items by sampling units, basis 15 replicated 10-percent samples per sampling unit, 1936/1935 and 1937/1936, with comparisons, Hancock County, Iowa.

ITEM AND COMPARISON	1935 U. S. Census	1935 State Farm Census		County universe year-to-year change	Standard Deviation				
		Percent of total farms reporting item	Average per farm (all farms†)		Random Indi- vidual Farm	Random Route	Random Single- Section Block	Random Four- Section Block	Purpo- sive Single- Standard Deviation Section Block
All land in farm (acres) 1936/1935 1937/1936	Percent 100.0		Acres 180.42	Percent 99.8 99.6	1.91 2.49	1.64 1.39	1.77 1.73	1.86 1.65	1.38 1.51
Corn, total (acres) 1936/1935 1937/1936	94.0		54.99	109.7 107.2	2.62 3.39	2.14 2.14	2.47 2.93	2.69 2.77	2.84 3.28
Oats harvested for grain (acres) 1936/1935 1937/1936	86.6		47.92	107.3 93.3	3.24 3.18	2.89 1.44	3.93 2.60	3.89 2.45	2.52 3.36
Barley harvested for grain (acres) 1936/1935 1937/1936	10.2		1.58	186.1 34.5	81.60 9.19	86.69 8.98	42.61 7.24	47.40 9.14	50.12 12.58
Sows bred for spring farrow (head) 1936/1935 1937/1936	77.8		7.93	110.7 95.5	2.95 1.84	2.68 3.41	5.06 3.30	4.98 3.64	5.20 6.20

\*Basis of deviations of sample year-to-year changes from county universe year-to-year change.  $N=15$ .

†Basis published data.



### Conclusions

Our conclusions, based on the above research in sampling procedure, are as follows:

(1) For the areas studied, which are fairly typical of the range of conditions in the Corn Belt States, and with geographical stratification of the samples within counties, the differences in accuracy between the four types of sampling units smaller than the Minor Civil Division are not highly significant. This may be due to a high degree of success in stratification.

(2) A previous study of sampling procedure for Morrow County, Ohio, showed that it would require 15 percent more farms enumerated in pairs, and 94 percent more farms canvassed in strings of 8, to make estimates as accurate as those secured by taking individual farms. With stratification, these percentages were reduced to 11 and 64 percent respectively. The fact that the present study shows very little if any difference in results, as between the route and section block sampling, and the individual farm unit, may at first appear contradictory. Actually this is not the case. The Morrow County study was based upon an analysis of independent annual samples, using 1935 United States Census data; the present study was concerned with sampling year-to-year change. The differences resulting from the two methods simply indicate that year-to-year change is not as highly correlated between neighboring farms as are the absolute figures for a single year. This distinction is important as it affects estimating procedures.

(3) As the route method of sampling possesses a number of administrative advantages, the results of the present study suggest the desirability of making a more detailed analysis of this unit, particularly for areas where conditions are less homogeneous than in the Corn Belt.

(4) Doubling the size of sample reduced the error of estimate by approximately one-third. This is in line with theoretical expectations. The same increase in sample size would add, on the average, only one acreage item per county, to the number which could be sampled within the 2.5 and 5.0-percent limits. The cost of securing accurate sample data by enumeration on minor items appears to be prohibitive. For the major agricultural items a 10-percent coverage probably approaches the most efficient sample size, accuracy and cost both considered. Allowance must be made, of course, for the fact that the total cost of a sample census would not vary proportionately with the coverage.

(5) In general, it appears that only items characteristic of 75 percent or more of all farms can be sampled on a county basis with reasonable accuracy, using a 10-percent sample. For the counties studied the average number of acreage items per county within the 5.0-percent error limit for this size of sample was 5 out of 15.

(6) The results of this study suggest very strongly the desirability of further analysis on sampling year-to-year change for a larger universe, such as a group of counties or a type-of-farming area.

(7) Any sampling procedure selected for a sample census of agriculture should take into account the necessity for a measure of the in-and-out movement of farm land. Indications on this highly important factor are sorely needed, if only on a State basis. The possibilities of a combination of two types of sampling units, such as the Minor Civil Division and the individual farm should not be overlooked. A comparatively small sample of Minor Civil Divisions might furnish reasonably accurate indications of the trend in number of farms and total land in farms by States and Grand Divisions, which data could be used for an over-all correction factor, while a more extensive individual farm sample could be used to measure the relative shifts in individual crop acreages and livestock numbers for smaller geographic areas.



(8) It is generally assumed that the regular United States Census would furnish the base year data, and that a sample census would provide a basis for estimates in intercensal years. If this procedure is followed it is imperative that some system of farm identification be used in the Census base year, and that the coverage include idle as well as operated farms, potential farm land as well as land in agricultural production at the time of the enumeration. Otherwise there is no adequate base for drawing a representative sample (or samples) for use in intercensal years.

# APPENDIX

TABLE 10.—Number of Minor Civil Divisions, land area, number of farms, and farm acreage data, 19 counties, 1935

State and County	Number of Minor Civil Divisions	1935 United States Census													Percentage Utilization of Farm Land. 1934			
		Land Area	Number of Farms	Average Size of Farms	All Land in Farms	Proportion of Land Area in Farms	Crop Land				Pasture			Woodland not Pastured	All Other Land in Farms			
							Har-vested	Failure	Idle or Fallow	Plow-able	Wood-land	Other						
No.	Acres	No.	Acres	Acres	Acres	%	%	%	%	%	%	%	%	%	%			
INDIANA																		
Benton	11	261,120	1,175	213.8	251,166	96.2	69.5	6.8	5.4	12.2	1.9	0.9	0.1	3.2				
Harrison	13	311,040	2,883	93.0	267,977	86.2	27.8	0.5	10.6	15.0	9.2	9.2	16.4	11.3				
Henry	13	254,080	2,565	92.0	236,070	92.9	56.7	1.0	4.3	19.1	6.6	5.3	2.1	4.9				
Noble	13 <sup>1</sup>	266,880	2,545	95.7	243,608	91.3	53.8	1.4	4.2	11.8	8.9	10.4	3.3	6.2				
IOWA																		
Audubon	12	283,520	1,879	150.2	282,293	99.6	55.8	0.7	4.7	27.8	1.4	4.1	0.2	5.3				
Clarke	12	273,920	1,556	170.0	264,459	96.5	33.9	11.6	3.4	18.3	9.4	17.7	1.0	4.7				
Delaware	16	365,440	2,345	150.1	351,921	96.3	56.7	0.9	1.6	16.1	6.2	12.9	0.7	4.9				
Hancock	16	364,800	2,035	173.6	353,263	96.8	69.6	0.7	3.4	15.1	0.4	4.3	0.2	6.3				
Jefferson	12	275,840	1,898	138.3	262,504	95.2	41.8	8.0	1.9	15.2	11.6	17.0	0.5	4.0				
Poweshiek	16	371,200	2,263	159.1	360,146	97.0	42.5	3.6	1.5	31.3	2.3	13.9	0.6	4.3				
KANSAS																		
Brown	10	365,440	2,294	152.9	350,780	96.0	61.2	1.3	5.7	11.7	5.1	9.2	0.9	4.9				
Marion	24	609,920	2,527	223.3	564,235	92.5	54.2	2.7	4.7	2.7	0.3	30.9	0.7	3.8				
Trego	7	575,360	963	567.5	546,485	95.0	20.9	24.1	8.6	9.5	0.1	34.1	0.1	2.6				
MINNESOTA																		
Isanti	13	282,880	2,168	119.7	259,427	91.7	42.1	7.3	3.1	4.5	23.3	8.2	4.2	7.3				
McLeod	14	317,440	2,550	119.5	304,846	96.0	65.1	2.0	0.3	5.6	5.9	14.1	0.7	6.3				
Martin	20	460,160	2,505	175.0	438,310	95.3	73.8	1.4	2.6	10.4	0.9	4.6	0.3	6.0				
Norman	24	550,400	2,068	259.6	536,838	97.5	67.5	2.1	5.3	9.2	4.8	2.2	2.4	6.5				
WISCONSIN																		
Dodge	24	574,080	4,735	111.2	526,465	91.7	62.2	0.6	0.5	8.4	5.2	15.2	1.3	6.6				
Green	16	379,520	2,478	145.8	361,399	95.2	44.4	0.9	0.9	27.1	7.1	13.2	1.6	4.8				

<sup>1</sup> Including Albion Village Minor Civil Division.



TABLE 11.—Size of sample by sampling units, 19 counties, 10 percent samples, basis total farm land, 1935-37

State and County	Random Individual Farm			Judgment Route			Random Single-Section Block			Random Four-Section Block		
	1935	1936	1937	1935	1936	1937	1935	1936	1937	1935	1936	1937
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
INDIANA												
Benton <sup>1</sup>	11.8	12.1	12.6	12.8	12.6	12.9	10.6	9.7	10.3	10.9	10.6	11.4
Harrison	10.6	10.9	11.5	11.4	11.6	11.6	11.2	11.6	11.9	11.0	10.5	11.3
Henry	12.0	12.2	12.4	12.4	12.3	12.3	9.8	10.3	10.2	9.5	9.7	9.7
Noble	10.6	10.9	10.8	12.3	12.4	12.8	10.2	10.3	10.9	11.2	11.7	12.2
IOWA												
Audubon	10.8	10.8	10.6	12.4	12.5	12.4	11.0	10.8	10.9	11.5	11.3	11.2
Clarke	11.2	11.2	10.9	12.9	13.1	13.1	10.5	10.9	10.9	10.9	10.9	11.1
Delaware	11.4	11.4	11.4	12.9	12.6	12.8	12.0	11.5	11.7	12.0	11.8	11.9
Hancock	10.7	10.5	10.7	11.2	11.2	11.0	11.0	11.2	11.1	11.1	11.5	11.4
Jefferson	10.6	10.7	11.0	12.4	12.3	12.4	11.3	11.5	11.6	11.4	11.7	11.4
Poweshiek	11.6	11.5	12.0	12.2	11.7	12.2	10.0	10.3	10.3	10.4	10.6	10.4
KANSAS												
Brown	9.2	9.5	9.0	9.3	9.5	9.4	9.4	9.2	9.4	9.2	9.4	9.2
Marion	11.8	11.7	11.2	11.6	11.4	11.4	11.4	12.0	12.0	10.7	10.3	10.2
Trego	12.8	13.0	13.5	10.4	10.7	11.1	12.4	12.2	12.2	10.6	10.6	10.7
MINNESOTA												
Isanti	10.7	11.2	12.1	12.0	12.4	12.7	10.0	11.0	11.0	10.5	11.4	11.6
McLeod	11.2	11.2	11.2	12.2	12.1	12.2	11.1	11.0	11.1	11.3	11.6	11.6
Martin	11.1	11.1	11.4	11.7	11.8	12.0	9.8	9.9	10.2	11.0	11.1	10.9
Norman	10.0	10.3	11.2	11.2	11.4	12.0	10.0	10.5	11.2	10.6	10.6	11.5
WISCONSIN												
Dodge	10.9	11.0	10.9	11.5	11.4	11.5	10.6	10.6	10.7	10.6	10.6	10.7
Green	11.7	11.6	11.9	11.2	11.1	11.3	10.4	10.4	10.4	10.5	10.7	10.8

<sup>1</sup>All 1936/1935 comparisons for Benton County are based upon 10 Minor Civil Divisions only. 1935 State Farm Census data not available for Grant Minor Civil Division.

TABLE 14.—Average size of farms by counties and sampling units, 20-percent samples, with State Farm Census and United States Census comparisons.<sup>1</sup>

State and County	Sampling Unit												United States Census	
	Random Individual Farm			Judgment Route			Random Single-Section Block			Random Four-Section Block			State Farm Census <sup>2</sup>	
	1935-37		1935	1935-37		1935	1935-37		1935	1935-37		1935		
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
INDIANA														
Benton	231.7	233.1	241.3	245.9	223.1	232.9	229.5	231.0	229.5	231.0	210.2	210.9	213.0	213.8
Harrison	98.0	102.7	106.6	113.0	98.1	101.8	93.0	96.8	93.0	96.8	97.3	96.8	99.2	93.0
Henry	101.1	108.4	105.8	112.8	97.0	104.9	102.4	113.4	102.4	113.4	97.8	95.3	97.1	92.0
Noble	99.7	106.4	114.8	117.9	98.7	102.1	107.0	113.5	107.0	113.5	103.6	102.1	106.4	95.7
IOWA														
Audubon	141.3	146.6	157.7	164.6	133.5	144.9	137.2	147.5	137.2	147.5	153.7	153.3	154.7	150.2
Clarke	153.4	167.9	177.3	189.6	150.2	163.3	154.6	171.7	154.6	171.7	174.8	171.0	171.4	170.0
Delaware	149.0	157.3	156.7	165.5	140.1	149.8	148.4	156.0	148.4	156.0	157.7	158.4	157.3	150.1
Hancock	169.8	182.1	174.5	175.9	166.8	176.9	173.3	177.9	173.3	177.9	181.1	179.3	181.9	173.6
Jefferson	135.8	141.2	143.4	145.5	127.0	135.4	126.0	134.5	126.0	134.5	142.6	141.9	137.8	138.3
Poweshiek	160.0	172.7	168.8	178.2	144.7	160.4	145.4	162.8	145.4	162.8	167.6	169.5	162.0	159.1
KANSAS														
Brown	165.5	175.8	170.0	178.3	170.9	182.0	158.4	173.7	158.4	173.7	173.0	172.7	160.8	152.9
Marion	210.5	244.7	212.7	242.5	209.0	228.5	205.9	230.9	205.9	230.9	232.1	233.4	231.4	223.3
Trego	528.2	567.1	542.7	583.8	497.0	595.3	482.3	552.1	482.3	552.1	586.4	593.4	553.2	567.5
MINNESOTA														
Isanti	126.3	128.4	125.4	124.3	118.4	117.2	121.0	123.0	121.0	123.0	115.8	119.8	120.7	119.7
McLeod	120.2	123.8	127.9	128.8	120.8	122.0	120.0	119.9	120.0	119.9	120.1	120.9	121.3	119.5
Martin	175.6	179.1	184.4	186.6	180.0	181.8	177.4	179.8	177.4	179.8	177.9	179.1	174.2	175.0
Norman	261.7	256.8	272.9	275.9	251.6	257.1	264.5	271.6	264.5	271.6	249.1	254.3	253.2	259.6
WISCONSIN														
Dodge	114.5	115.5	117.2	117.0	116.8	118.0	118.9	118.1	118.9	118.1	111.3	113.4	112.4	111.2
Green	163.7	161.2	160.5	163.0	149.7	154.5	156.5	161.2	156.5	161.2	153.0	155.1	149.5	145.8
Weighted Avg.	—	164.4	—	170.6	—	161.5	—	163.1	—	163.1	159.5	—	—	155.7

<sup>1</sup> The 1935-37 averages for the samples were computed on the basis of 1937 farm acreage and number of farms tabulated for any one or more of the three years: 1935, 1936, and 1937. The 1935 averages for the samples were computed on the basis of number of farms and farm acreage tabulated for 1935 only, i. e., excluding reports showing no farm acreage for 1935.

<sup>2</sup> Basis published data.



















